

Modern Concepts of Cardiovascular Disease

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No. 9

EVALUATION OF SURGICAL METHODS IN THE TREATMENT OF CORONARY ARTERY DISEASE*

The greatest untapped reservoir of acquired heart disease in which surgery may be feasible is that of coronary artery disease. The status of various surgical procedures is still disputed today, as was sympathectomy for angina pectoris when first proposed in 1899.¹ As in any scientific controversy over conclusions,² there are three categories of individuals: (1) the enthusiastic innovators who consider the diagnosis of coronary arteriosclerosis as sufficient indication for surgery;³ (2) those who are opposed to surgery; and (3) those who insist upon obtaining more definitive data before they join either of the first two groups. The innovators have enriched the clinical literature with reports of discarded operations, each brilliantly conceived, widely heralded, and later reluctantly and quietly buried, thus confirming the pessimism of the doubters. The third category, to which the author belongs, recognizes that surgery is part of cardiology and may have a place in the treatment of coronary disease.

The purpose of this report is to appraise the current surgical methods, their experimental bases, their clinical application and their results.

The *clinical course* of patients with coronary arteriosclerosis and insufficiency is extremely variable in different patients, and in the same patient at different periods, and may be altered by diet, emotions, life activities, endocrine function, and medical therapy. The *clinical effects*, however, are less variable. When the process of stenosis and occlusion exceeds that of collateral vessel formation, coronary arterial inflow is reduced. This produces: (1) angina pectoris, anxiety, and even invalidism, often unrelated to the severity of the disease; (2) myocardial damage, fibrosis, infarction, shock, congestive failure, thrombo-embolism, or rupture; and (3) mechanism failure, i.e., arrhythmias, ventricular fibrillation or asystole. *The end result is variable disability and usually premature death.*

Since the effects of coronary insufficiency may be so clearly defined, it is regrettable that the present controversy concerning the value of surgery for coronary disease has not been resolved since the first surgical attack 22 years ago.⁴ Unfortunately, no report with proper controls has been published except that of Lindgren,⁵ who compared patients treated medically with those treated surgically.

AIMS OF SURGICAL TREATMENT

The purpose of surgical treatment is to relieve, as far as possible, the adverse effects of the reduction of coronary arterial inflow. The methods used are the following: (I) denervation of the heart; (II) improvement of the circulation of the myocardium; and (III) reduction of the metabolic demands on the coronary circulation by thyroid ablation.

I. Denervation of the Heart

The purpose of neurosurgical intervention is to interrupt the sensory pathways of the heart, and to block the pathways for vasomotor impulses to the coronary arteries.

Anatomic basis. The majority of pain fibers from the heart pass through the inferior cervical sympathetic ganglia and the upper three or four thoracic sympathetic ganglia on both sides.^{6, 7}

Experimental proof of benefit of denervation of the heart. Cardiac pain could not be produced in dogs by traction on the left anterior descending artery, either after bilateral resection of the stellate and the upper thoracic sympathetic ganglia, or after section of the upper five pairs of thoracic posterior roots.⁸ Although clinical evidence suggests that vasomotor impulses may play an important role in producing anginal attacks, the significance of the nervous control of coronary blood flow has been difficult to determine experimentally, since stimulation of vasomotor nerves, both vagal and sympathetic,

* From the School of Medicine, Western Reserve University, and University Hospitals, Cleveland, Ohio.

produces concomitant changes in the heart beat and blood pressure. Consequently, the actions and pathways which vasomotor nerves travel are less clearly understood than those pathways of the sensory innervation of the heart.⁵

The beneficial effect of interruption of the pathways of pain on the coronary circulation of the dog have been reported⁹ with respect to the mortality rate from experimental myocardial infarction,¹⁰ the area of infarction, and collateral blood supply.¹¹

Improvement of the coronary circulation in man by sensory denervation has been suspected on the following bases: (1) after precordial anesthesia or extensive thoracic sympathectomy, standardized hypoxemic and exercise tests produced less pain and less electrocardiographic changes than before the procedure;¹² (2) improved work capacity; and (3) within 24 hours after paravertebral block, flat or negative T waves became upright in patients with angina pectoris, suggesting that blocking of sympathetic impulses "abolishes reflex spasm."¹³

Clinical application. There are three standard methods of sensory denervation of the heart: (1) chemical blocking of the upper thoracic sympathetic ganglia; (2) posterior rhizotomy; (3) cervicothoracic ganglionectomy.

1. Paravertebral chemical block (injection of procaine, or 95 per cent alcohol, into the upper four sympathetic ganglia). Several hundred patients have been subjected to this treatment. Excellent results (relief of anginal pain) were obtained in 73 to 84 per cent of the cases, with permanent relief in 47 to 64 per cent. The mortality rate was low, from zero in two series with more than 60 cases,^{14, 15} to 8 per cent in others.⁷

In approximately 10 per cent of the cases, an insufficient proportion of the afferent fibers were interrupted. Transient nerve block, with recurrence of pain and recovery of nerve conduction, occurred in 18.7 per cent of the cases after periods of 10 weeks to 5 years.⁷ Intercostal neuralgia occurred in nearly all cases, and was the source of persistent major complaints in approximately 10 per cent of the cases.

2. Posterior rhizotomy—section of the sensory (dorsal) roots of the first four thoracic nerves. Clinical application has been limited. The mortality rate was approximately 10 per cent. Immediate and complete relief of pain up to 10 years was obtained in 29 out of 30 cases.⁷

Instead of angina pectoris, some patients had a form of anesthesia dolorosa, i.e., recurrent or constant feeling of oppression in the chest, unrelieved by nitroglycerine. This complication, and the distress due to anesthesia of the upper five thoracic dermatomes, was sufficiently disagreeable to vitiate the results in some cases.¹⁶

The benefits in paravertebral block and posterior rhizotomy were mainly subjective. "Once

relieved of their pain, these patients are able to live happier and more active lives, free from fear of ever-recurring attacks, and less conscious of impending death. They are no longer threatened by addition to morphine, lack of sleep and worry. . . ."⁷ Many of the patients who had been bedridden or confined to the house were able to resume an active life.

There are no reports with observations on a control group of nonoperated cases, no evidence of enhanced survival, and no data on the measured response to exercise or loading before and after surgery.

To summarize: Paravertebral chemical block and posterior rhizotomy are direct approaches to the relief of pain, yielding relief in over 75 per cent of the cases, with low mortality rates, low recurrence rates, tolerable complications, clinical evidence of slight improvement of myocardial function, but no proof of improvement of prognosis. Posterior rhizotomy involves a longer operative time. However, there is no possible chance of regeneration, and the cardiac afferent fibers can be cut on both sides at a single operation.

3. Cervicothoracic ganglionectomy (surgical removal of the stellate, and the second and third thoracic⁷ or the second to fourth thoracic ganglia).⁵ The most comprehensive study is that of Lindgren⁵, who personally evaluated 80 out of 105 patients subjected to cervicothoracic ganglionectomy and a control group of 88 patients. Both groups were comparable as to age, sex, incidence of hypertension, cardiac hypertrophy, previous infarction (50 per cent), heart failure (25 per cent), electrocardiographic changes, symptoms and signs. The study extended over a four-year period. The operative mortality was 8.6 per cent.

Myocardial infarction was the most serious operative complication, occurring in 10 out of 80 cases and proving fatal in 2 cases. Migration of anginal pain to a new area occurred in 35 per cent, and was so severe in 10 per cent as to vitiate the beneficial effect of the operation. Traumatic neuritis was reduced from 65 per cent of the first 50 cases, to 15 per cent of the last 30 cases. Other complications of lesser importance included Horner's syndrome, nasal congestion, and changes in peripheral vascular tone. There was no evidence that interruption of the sensory pathways abolished a warning that the heart was being overtaxed. Although the patient no longer had angina after the operation, a vague sense of retrosternal distress or oppression served as an anginal equivalent.

Criteria of benefit were determined as follows:

Subjective evaluation. The effect of operation on anginal pain, working capacity, and general condition was studied by the questionnaire technique. In the patients who survived the opera-

Program

THE THIRTIETH SCIENTIFIC SESSIONS

of the

AMERICAN HEART ASSOCIATION

COMMEMORATING THE TERCENTENARY OF WILLIAM HARVEY

Hotel Sherman

Chicago, Illinois

October 25-28, 1957

FRIDAY

OCTOBER 25, 1957

SPECIAL SCIENTIFIC SESSION FOR PHYSICIANS IN GENERAL MEDICINE

9:00 A.M. to 12:30 P.M.

Chairman: HOWARD B. SPRAGUE, Boston, Mass.

Prevention and Management of Cardiovascular Emergencies

- ... In Pregnancy—James Metcalfe, Boston, Mass.
- ... In Children—Benjamin M. Gasul, Chicago, Ill.
- ... During Anesthesia—Robert A. Hingson, Jr., Cleveland, Ohio

INTERMISSION

- ... After Surgery—Louis A. Soloff, Philadelphia, Pa.
- ... During Drug Therapy—Maurice Sokolow, San Francisco, Calif.
- ... In Anxiety States—Stewart G. Wolf, Jr., Oklahoma City, Okla.

2:00 P.M. to 5:00 P.M.

PANEL: Prevention and Management of Cardiovascular Emergencies

(Panel presentation to be followed by questions and discussion from the floor)

Howard B. Sprague, Boston, Mass., MODERATOR

Speakers of the Morning Session

INTERMISSION

PANEL: Unsettled Clinical Questions in the Management of Cardiovascular Disease

Louis N. Katz, Chicago, Ill., MODERATOR

George E. Burch, New Orleans, La.

Albert Dorfman, Chicago, Ill.

A. Carlton Ernestene, Cleveland, Ohio

Hans H. Hecht, Salt Lake City, Utah

Robert L. Parker, Rochester, Minn.

Symposium on Heart Sounds and Murmurs

9:00 A.M. to 5:00 P.M.

Chairman: VICTOR MCKUSICK, Baltimore, Md.

Instrumental Methods in Cardiovascular Diagnosis

8:00 P.M. to 11:00 P.M.

Chairman: CHARLES E. KOSSMANN, New York, N. Y.

Co-Chairman: JEREMIAH STAMLER, Chicago, Ill.

Left Atrial Electrocardiography in Mitral Insufficiency in Man: Correlative Study by Angiocardiography, Left Heart Catheterization, and Experimental Production in Dogs. Richard D. Judge, Melvin M. Figley, and Herbert E. Sloan, Jr., Ann Arbor, Mich.

Use of Coronary Arteriography in Human Coronary Sclerosis. Alan P. Thal, Richard G. Lester, L. Stephen Richards, and M. John Murray, Minneapolis, Minn.

Use of a New Sagittal Lead for the Estimation of Ventricular Hypertrophy. Ernest W. Reynolds, Jr., and Franklin D. Johnston, Ann Arbor, Mich.

Critical Study of Existing ECG Lead Systems to Evolve One Useful Interchangeably for Scalar, Vector, and Electronic Computer Analysis. Ernst Simonson and Otto H. Schmitt, Minneapolis, Minn.

Critical Evaluation of the Equivalent Cardiac Dipole Concept. Ralph F. Morton and Daniel A. Brody, Memphis, Tenn.

INTERMISSION

Clinical Application of a New Dye for Continuous Recording of Arterial Dilution Curves Independently of Variations in Blood Oxygen Saturation. Irwin J. Fox, Rochester, Minn., Leslie G. Brooker, Donald W. Heseltine, Rochester, N. Y., and Earl H. Wood, Rochester, Minn.

Place of Intracardiac Phonocardiography in the Diagnosis of Heart Disease in Man. George W. Deitz, Ali Ertugrul, Philadelphia, Pa., John D. Wallace, James R. Brown, Jr., Johnsville, Pa., and David H. Lewis, Philadelphia, Pa.

High Sensitivity Pickup for Cardiovascular Sounds. *Dale Groom, Charleston, S. C., and Yro T. Sihvonen, Detroit, Mich.*

Instantaneous Measurement of Oxygen Saturation at Cardiac Catheterization, Using Reflected Light. *W. G. Zijlstra, G. A. Mook, Groningen, The Netherlands, and A. S. Nadas, Boston, Mass.*

Cinefluorography of the Heart and Lungs. *Robert S. Green, Cincinnati, Ohio.*

SATURDAY MORNING OCTOBER 26, 1957

GENERAL SCIENTIFIC SESSION

9:00 A.M. to 12:30 P.M.

Chairman: EDGAR V. ALLEN, Rochester, Minn.

Co-Chairman: GEORGE E. BURCH, New Orleans, La.

OPENING ADDRESS: EDGAR V. ALLEN SPECIAL AWARDS PRESENTATION

Screening Test for Renal and Adrenal Forms of Hypertension, Based Upon Postural Change in Blood Pressure. *Reginald H. Smithwick, Dera Kinsey, and George P. Whitelaw, Boston, Mass.*

Diagnostic Applications of Indicator Dilution Technics in Congenital and Acquired Heart Disease. *H. J. C. Swan and Earl H. Wood, Rochester, Minn.*

Blood Pressure in White People Over 65 Years of Age. *Arthur M. Master, Richard P. Lasser, and Harry L. Jaffe, New York, N. Y.*

Study of the Manifestations of Rheumatic Fever Following Cessation of Therapy. *Edward E. Fischel, Charles W. Frank, and Majorie T. Bellows, New York, N. Y.*

Comparison of Oral Penicillin and Oral Sulfadiazine in a Controlled Study of Three Methods of Prophylaxis Against Streptococcal Infection in a Population of Rheumatic Children. *Harrison F. Wood, Alvan R. Feinstein, Ilse Hirschfeld, Rita Simpson, Angelo Taranta, Raymond C. Haus, Konrad Ulich, Carlos Manso, Arthur J. Lewis, Jeanne A. Epstein, and Lawrence Rothfeld, Irvington-on-Hudson, N. Y.*

Late Hemodynamic Complications of Anastomotic Procedures for Cyanotic Congenital Heart Disease. *Richard S. Ross, Melvin H. Evans, and Helen B. Taussig, Baltimore, Md.*

INTERMISSION

THE LEWIS A. CONNER MEMORIAL LECTURE:

Rheumatic Heart Disease—A Challenge
Charles H. Rammelkamp, Jr., Cleveland, Ohio

SATURDAY AFTERNOON OCTOBER 26, 1957

SIMULTANEOUS SCIENTIFIC SESSIONS

Basic Science*

2:00 P.M. to 5:00 P.M.

Chairman: ERIC OGDEN, Columbus, Ohio

Co-Chairman: JAMES W. McCUBBIN, Cleveland, Ohio

*NOTE: Joint all-day session by the Microcirculatory Conference and the Council on Basic Science, Friday, October 25, 1957.

Radioactive Fat Absorption Patterns: Their Significance in Coronary Artery Atherosclerosis. *William Likoff, Donald Berkowitz, Asher Woldow, and Gerson Jacobs, Philadelphia, Pa.*

Function of the A-V Conduction Tissue. *Allen M. Scher, Juhan Liikane, Malcolm E. Fishback, and Leland L. Burnett, Seattle, Wash.*

Coronary Flow and Oxygen Metabolism. *Louis N. Katz, Harold Feinberg, and Augusto Gerola, Chicago, Ill.*

Effect of Alteration of Coronary Perfusion Pressure on the Oxygen Uptake of the Left Myocardium. *Donald E. Gregg, Claudia R. Rayford, Edward M. Khouri, Albert A. Kattus, and William P. McKeever, Washington, D. C.*

Dynamics of the Coronary Collateral Flow in the Normal Open Chest Dog. *Albert A. Kattus, and Donald E. Gregg, Washington, D. C.*

INTERMISSION

Production of Experimental Myocardial Failure by Coronary Artery Embolization. *Emanuel Marcus, Louis N. Katz, Ruth Pick, and Jeremiah Stamler, Chicago, Ill.*

On Computing Cardiac Work. *Carl R. Honig, Rochester, N. Y., and Stephen M. Tenney, Hanover, N. H.*

Pulmonary Vascular Responses to Serotonin and the Effects of Certain Serotonin Antagonists. *John C. Rose, Washington, D. C.*

Cardiac Control in Intact Dogs. *Robert F. Rushmer, Dean L. Franklin, Robert W. Moss, and Allan W. Lobb, Seattle, Wash.*

Circulation

Business Meeting: 1:30 P.M.

Session: 2:00 P.M. to 5:00 P.M.

Chairman: HERBERT CHASIS, New York, N. Y.

Co-Chairman: MILTON MENDLOWITZ, New York, N. Y.

Measurement of Cardiac Output in the Steady State by the Fick Principle During Combined Right and Left Heart Catheterization. *Philip Samet, William H. Bernstein, Robert S. Litwak, Hyman Turkewitz, and Leonard Silverman, Miami Beach, Fla.*

Hemodynamic Reactions to Endotoxin. *Robert P. Gilbert, Chicago, Ill., Hiroshi Kuida, Salt Lake City, Utah, Lerner B. Hinshaw, James Vick, and Maurice B. Visser, Minneapolis, Minn.*

Method for the Detection and Estimation of the Magnitude of Aortic Regurgitant Flow. *Eugene Braunwald and Andrew G. Morrow, Bethesda, Md.*

Chlorothiazide in the Management of Edema of Heart Failure, Nephrosis and Cirrhosis. *John H. Laragh and Felix E. Demartini, New York, N. Y.*

Hemodynamic Effects of Vasodilatation Induced by Sodium Nitrite in Congestive Heart Failure: Relationship to Starling's Law of the Heart. *Albert M. Ziffer, Bertha Rader, and Ludwig W. Eichna, New York, N. Y.*

INTERMISSION

Electrolyte and Water Metabolism in Cardiac Patients with Early Congestive Heart Failure. *Aram V. Chobanian, Belton A. Burrows, and William Hollander, Boston, Mass.*

Splanchnic Blood Volume in Congestive Heart Failure. *Elliot Rapaport, San Francisco, Calif., Myron H. Weisbart, and Milton LeVine, Albany, N. Y.*

THE ANNUAL MEETING
and
30th Annual Scientific Sessions
of the
AMERICAN HEART ASSOCIATION
October 25 through October 29, 1957
Headquarters: Hotel Sherman
Chicago, Illinois

ALL MEETINGS WILL BE HELD AT THE HOTEL SHERMAN

FRIDAY, OCTOBER 25 Advance Registration

MEETING SCHEDULE

FRIDAY, OCTOBER 25 all day Special Scientific Session for Physicians in General Medicine
8:00 P.M. Special Session—
Instrumental Diagnostic Methods in Cardiology

SATURDAY, OCTOBER 26 30th Annual Scientific Sessions
Program of Council on Community Service and Education
through Program of the Council on Rheumatic Fever and Congenital Heart
Disease

MONDAY, OCTOBER 28 Program of the Staff Conference of Heart Associations

MONDAY, OCTOBER 28 A. H. A. Assembly Panel Meetings

TUESDAY, OCTOBER 29 A.M. Annual Meeting of the A. H. A. Assembly—
elections—panel reports
P.M. Luncheon and Business Meeting—Staff Conference

SOCIAL FUNCTIONS

FRIDAY, OCTOBER 25 Staff Conference Dinner

SATURDAY, OCTOBER 26 Council on Rheumatic Fever and Congenital Heart Disease—Luncheon

SUNDAY, OCTOBER 27 Community Service and Education—Luncheon
A. H. A. Annual Dinner Dance—presentation of Gold Heart awards

MONDAY, OCTOBER 28 A. H. A. Assembly Luncheon

AMERICAN HEART ASSOCIATION

ADVANCE REGISTRATION

Name
(Please Print) (Last Name) (First Name)

Address

City Zone..... State.....

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(Local Heart Association)

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CIRCULATION RESEARCH ☐

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CIRCULATION RESEARCH ☐

Please check

- ☐ Physician
☐ Non-Medical
☐ Medical Student
☐ Registered Nurse
☐ Exhibitor

APPLICATION FOR HOTEL ACCOMMODATIONS

NOTE: Single rooms are limited in number. Please arrange to occupy twin-bedded room.

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							\$12.45	\$12.95	\$13.45	\$13.95
Room with Double Bed for 2 Persons..			\$10.45	\$11.45	\$11.95	\$12.95	\$13.45	\$13.95	\$14.45	
			\$14.95	\$15.45	\$15.95	\$16.45	\$16.95	\$17.45	\$17.95	
Twin bedded rooms.....			\$13.45	\$13.95	\$14.45	\$14.95	\$15.45	\$15.95	\$16.45	
						\$16.95	\$17.45	\$17.95	\$18.95	
Alcoves (Sitting Room-Bedroom Combination)							\$22.95	\$23.95	\$24.95	
Parlor and One Twin Bedroom.....						\$23.95	\$29.95	\$36.95	\$38.95	
Parlor and Two Twin Bedrooms.....								\$54.90	\$65.00	
Two Rooms with Connecting Bath (Not available with Twin Beds) For Two Persons..								\$13.90	\$15.90	
								Three Persons ...	\$17.90	\$19.90
								Four Persons	\$21.90	\$23.90

Please reserve the following: (Rates subject to change)

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 _____ Parlor, one double room with bath.....Rate \$ _____ to \$ _____ per room
 _____ Parlor, two double rooms with bath.....Rate \$ _____ to \$ _____ per room

A.M.

Arrival date _____ hour P.M. Leaving _____

NOTE: YOU WILL RECEIVE CONFIRMATION DIRECT FROM HOTEL.

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1	_____	_____	_____	_____
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3	_____	_____	_____	_____
4	_____	_____	_____	_____
5	_____	_____	_____	_____

ADDRESS THIS FORM TO:

Housing Bureau
American Heart Association, Inc.
44 East 23 Street
New York 10, New York

NOTICE

PLEASE CHECK QUESTIONNAIRE ON BACK PAGE

FOR THE LADIES

The Chicago Heart Association will be your host during the American Heart Association Annual Meetings. For your convenience they are providing a Hospitality Lounge which will be open Friday, October 26 through Monday, October 28.

Hostesses will be there to greet you and to take care of your registration. The lounge will provide an ideal spot to meet your friends. Playing cards and magazines will be available as well as a list of places of interest, television shows, etc.

SPECIAL EVENTS

Saturday, October 26

Art Institute

2:00 P.M. to 4:00 P.M.

Interesting and informative visit to Chicago Art Institute

Sunday, October 27

Sightseeing

1:30 P.M. to 4:00 P.M.

Bus tour of Chicago, including the Chrysanthemum Show at Garfield Park and the Giant Heart exhibit in the Museum of Science and Industry

Monday, October 28

Fashion Show and Tea

3:00 P.M. to 4:30 P.M.

Wedgewood Room, Marshall Field and Company

NOTICE

PLEASE CHECK QUESTIONNAIRE ON BACK PAGE

HAWAII in 1958???

POST CONVENTION TRIP FROM SAN FRANCISCO FOR SCIENTIFIC MEETING IN HAWAII

PLAN 1

Round trip by Steamer \$260 and \$277.50 per person and up

PLAN 2

Round trip by Plane \$320 per person—first class
\$250 per person—tourist

PLAN 3

One Way by Steamer } \$313 per person and up—first class
One Way by Plane } \$270 per person and up—tourist

HOTEL ACCOMMODATIONS (European Plan)

\$10 to \$20 single per day
\$12 to \$22 twin per day

Please indicate your interest below. If enough interest is shown we will proceed with arrangements. Details would then be available at our October meeting in Chicago.

All above prices are approximate

I am tentatively planning to take the trip to Hawaii in 1958

self () wife () others () indicate number
Plan 1 () Plan 2 () Plan 3 ()

SITES OF FUTURE SCIENTIFIC SESSIONS & ANNUAL MEETINGS

1958 — October 24-28 San Francisco, California
1959 — October 23-27 Philadelphia, Pennsylvania
1960 — October 21-25 St. Louis, Missouri

TENTATIVE

1961 — October 27-31 Miami Beach, Florida
1962 — October 26-30 Chicago, Illinois

Abnormalities of Blood Distribution in Congestive Heart Failure. *William R. Milnor and Lucien A. Campeau, Baltimore, Md.*

Comparative Cardiac Effects of Various Sympathomimetic Amines. *James W. West, Santiago V. Guzman, and Samuel Bellet, Philadelphia, Pa.*

Clinical Cardiology

2:00 P.M. to 5:00 P.M.

Chairman: *WILLIAM P. THOMPSON, Los Angeles, Calif.*

Co-Chairman: *WRIGHT R. ADAMS, Chicago, Ill.*

Correlative Study of Postmortem, Electrocardiographic and Spatial Vectorcardiographic Data in Myocardial Infarction. *George E. Burch, Leo Horan, Joseph Ziskind, and James Cronvich, New Orleans, La.*

Role of Electrolytes in the Origin of Ischemic Cardiac Pain and Associated Electrocardiographic Abnormalities. *Richard S. Gubner and Donald J. Behr, New York, N. Y.*

Electrocardiographic Syndrome of Short P-R Interval and Broad QRS Complexes: Clinical Study of 80 Cases. *Milton R. Hejtmanick and George R. Herrmann, Galveston, Tex.*

Uncommon Types of Cardiovascular Disease Associated with Free Aortic Regurgitation into the Heart. *Oglesby Paul, John S. Graettinger, and Arnold Brown, Chicago, Ill.*

Backflow in the Aorta of Patients with Aortic Insufficiency Studied with an Indicator Technic. *Homer R. Warner and Alan F. Toronto, Salt Lake City, Utah.*

INTERMISSION

Observations on the Significance of the Delayed Appearance of the First Heart Sound in Mitral Stenosis. *James J. Leonard, Arnold M. Weissler, and James V. Warren, Durham, N. C.*

Comparison Between Electrocardiograms of Left Atrium and Left Atrial Pressure Patterns in Lesions of the Mitral Valve. *Chi K. Liu and Aldo A. Luisada, Chicago, Ill.*

Cardiac Effects of Sympathomimetic Amines in Experimental Complete Heart Block. *Arthur J. Linenthal, Paul M. Zoll, Leona R. Norman, William Gibson, and Hussein A. Shustari, Boston, Mass.*

Enhancement and Inhibition of Diuresis in Congestive Heart Failure. *Stanley L. Kass, Jacob Grossman, Raymond E. Weston, and Louis Leiter, New York, N. Y.*

Rheumatic Fever and Congenital Heart Disease

Business Meeting: 1:30 P.M.

Session: 2:00 P.M. to 5:00 P.M.

Chairman: *MACLYN McCARTY, New York, N. Y.*

Co-Chairman: *JESSE E. EDWARDS, Rochester, Minn.*

Early Postoperative Results Following Partial Correction of Transposition of the Great Vessels. *Robert A. Miller and Thomas G. Baffes, Chicago, Ill.*

Regression After Open Valvotomy of Infundibular Stenosis Accompanying Severe Valvular Pulmonic Stenosis. *Mary Allen Engle, George R. Holswade, Henry P. Goldberg, and Frank Glenn, New York, N. Y.*

Rapid Measurement of the pCO₂ of the Pulmonary Artery in Man: Clinical Use in the Diagnosis of Congenital Heart Disease in 75 Patients. *John J. Osborn, San Francisco, Calif.*

Pulmonary Diffusing Capacity in Valvular and Congenital Heart Disease. *J. Howland Auchincloss, Jr., Robert Gilbert, and Robert H. Eich, Syracuse, N. Y.*

Use of Nitrous Oxide in a New and Improved Method for the Detection of Left to Right Shunts. *Richard J. Sanders, Eugene Braunwald, and Andrew G. Morrow, Bethesda, Md.*

INTERMISSION

Localization of Intracardiac Shunts by Two-Site Sampling. *Milton G. Crane, John E. Holloway, Charles H. Sears, James A. McEachen, Ronald H. Selvester, and Ivor C. Woodward, Los Angeles, Calif.*

Hemodynamic Observations in 23 Patients with Pure Mitral Insufficiency. *John Ross, Eugene Braunwald, and Andrew G. Morrow, Bethesda, Md.*

Left Heart Angiography in the Diagnosis of Mitral or Aortic Insufficiency. *Robert J. Wilder, Baltimore, Md., and Howard L. Moscovitz, New York, N. Y.*

Simple Method Using Indicator-Dilution Curves to Differentiate Patients with Predominant Mitral Stenosis from Those with Predominant Regurgitation. *Edward Woodward, Jr., Howard B. Burchell, and Earl H. Wood, Rochester, Minn.*

SUNDAY MORNING

OCTOBER 27, 1957

GENERAL SCIENTIFIC SESSION

9:00 A.M. to 12:30 P.M.

Chairman: *IRVINE H. PAGE, Cleveland, Ohio*

Co-Chairman: *EDGAR A. HINES, Rochester, Minn.*

Direct Experimental Approaches to the Problem of Intraventricular Diastolic Suction. *Gerhard A. Brecher and Abbott T. Kissen, Columbus, Ohio.*

Ventilatory Mechanics in Pulmonary Edema in Man. *John T. Sharp, Geraint T. Griffith, Ivan L. Bunnell, and David G. Greene, Buffalo, N. Y.*

Circulation and Respiration in the Giraffe. *James V. Warren, Durham, N. C., John L. Patterson, Jr., Richmond, Va., Joseph T. Doyle, Albany, N. Y., Otto H. Gauer, Bad Nauheim, Germany, E. N. Keen, Capetown, S. Africa, Maurice McGregor, Johannesburg, S. Africa, and Robert H. Goetz, Capetown, S. Africa.*

Influence of Acidosis on Cardiac and Vascular Responsiveness to Epinephrine, Norepinephrine, and Metaraminol. *Max H. Weil, Duarte, Calif., Dudley B. Houle, E. B. Brown, Jr., Gilbert S. Campbell, Minneapolis, Minn., and Charles Heath, Edmonton, Alberta, Canada.*

Increasing Incidence of Liver Necrosis: Possible Relationship to Administration of Vasopressor Amines. *Philip L. Eckman, Joel G. Brunson, and John B. Campbell, Minneapolis, Minn.*

INTERMISSION

Differentiation of Types of Idiopathic Hypercholesterolemia by Serum Lipoprotein Distribution and Response to Therapy. *Edwin Boyle, Jr. and Henry M. McLaughlin, Charleston, S. C.*

Changes in the Serum Cholesterol and Blood Clotting Time in Men Subjected to Cyclic Variation of Emotional Stress. *Ray H. Rosenman and Meyer Friedman, San Francisco, Calif.*

THE GEORGE E. BROWN MEMORIAL LECTURE:

Current Evaluation of the Thrombosis Problem
Nelson W. Barker, Rochester, Minn.

SUNDAY AFTERNOON
OCTOBER 27, 1957
GENERAL SCIENTIFIC SESSION

2:00 P.M. to 5:00 P.M.

Chairman: ROBERT W. WILKINS, *Boston, Mass.*
Co-Chairman: RAY E. TRUSSELL, *New York, N. Y.*

**PRESENTATION OF
THE ALBERT LASKER AWARD**

On the Effect of Certain Unsaturated Fatty Acids on Serum Lipids. *Martin M. Nothman, Lowell Bellin, and Samuel Proger, Boston, Mass.*

Comparison of the Effects of β -Sitosterol and Safflower Oil, Alone and in Combination, on Serum Lipids of Humans: Long-Term Study. *John W. Farquhar and Maurice Sokolow, San Francisco, Calif.*

PANEL: Present Status of Lipid Metabolism and Atherosclerosis

Herbert Pollack, New York, N. Y., MODERATOR
Robert Olson, Pittsburgh, Pa.
Oglesby Paul, Chicago, Ill.
Herman E. Hilleboe, Albany, N. Y.

INTERMISSION

Water Metabolism After Cardiac Operations Involving Extracorporeal Circulation. *George S. Sturtz, John W. Kirklin, Edmund C. Burke, and Marschelle H. Power, Rochester, Minn.*

Phonocardiogram in Mitral Valvular Disease: Correlation with Left Heart Catheterization and Operative Findings. *Munro H. Proctor, Boston, Mass., Rhett P. Walker, Mobile, Ala., Ernest W. Hancock, and Walter H. Abelman, Boston, Mass.*

Posteromedial Annuloplasty—Correction of Acquired Mitral Insufficiency Under Direct Vision, Utilizing a Pump-Oxygenator: Clinical Experience. *K. Alvin Merendino, John E. Jesseph, Paul W. Herron, George I. Thomas, and Roy R. Vetto, Seattle, Wash.*

Physiologic Changes with Age in Ventricular Septal Defect. *Paul Adams, Ray C. Anderson, Peter Allen, and C. Walton Lillehei, Minneapolis, Minn.*

**COUNCIL ON COMMUNITY SERVICE
AND EDUCATION:**

3:30 P.M. to 5:00 P.M.

PANEL: Community Service—Its Nature and Its Significance for Heart Associations

Ray E. Trussell, New York, N. Y., MODERATOR
Dean K. Crystal, Seattle, Wash.
John Brundage, Montclair, N. J.
Helen O'Shaughnessey, New York, N. Y.
Stewart G. Wolf, Jr., Oklahoma City, Okla.

MONDAY MORNING
OCTOBER 28, 1957
SIMULTANEOUS SCIENTIFIC SESSIONS

Cardiovascular Surgery

9:00 A.M. to 12:30 P.M.

Chairman: FRANK GLENN, *New York, N. Y.*
Co-Chairman: JOHN H. GIBBON, JR., *Philadelphia, Pa.*

Experimental and Clinical Results with a Practical Membrane Blood Oxygenator. *George H. A. Clowes, Jr. and William E. Neville, Cleveland, Ohio.*

Postoperative Sequelae with the Bubble Dispersion Type Oxygenator: Antifoam Toxicity. *William A. Reed and C. Frederick Kittle, Kansas City, Kan.*

Use of the Heart-Lung Pump for the Direct Surgical Repair of Atrio-Septal Defects. *Alvin A. Bakst, Philip Crastnopol, and Irving G. Kroop, Brooklyn, N. Y.*

Plasma Concentrations of Epinephrine and Arterenal During Cardiopulmonary Bypass. *Eugene F. Woods, James A. Richardson, William H. Lee, Jr., John D. Ashmore, and Edward F. Parker, Charleston, S. C.*

Disposable Screen Oxygenator. *Gerald A. Diettert and Bernard A. Bercu, St. Louis, Mo.*

INTERMISSION

Surgical Correction of Chronic Mitral Insufficiency in Dogs. *Sam J. Kuykendall, F. Henry Ellis, Jr., and John H. Grindlay, Rochester, Minn.*

Coronary and Peripheral Blood-Flow Following Hemorrhagic Shock, Transfusion and Norepinephrine. *Keith D. J. Vowles, Cecil M. Couves, and John M. Howard, Atlanta, Ga.*

Surgical Treatment of Partial and Total Anomalous Pulmonary Venous Drainage. *Johann L. Ehrenhaft, Montague S. Lawrence, and Ernest O. Theilen, Iowa City, Ia.*

Evaluation of the Surgical Treatment of Patients with Coexisting Atrial Septal Defect and Pulmonary Valvular Stenosis. *Henry Swan and S. Gilbert Blount, Jr., Denver, Colo.*

High Blood Pressure

9:00 A.M. to 12:30 P.M.

Chairman: MEYER W. FRIEDMAN, *San Francisco, Calif.*
Co-Chairman: JAMES V. WARREN, *Durham, N. C.*

Studies on the Natural History of Adrenal Regeneration Hypertension. *Floyd R. Skelton, New Orleans, La.*

Enhancement of Antihypertensive Activity with Chlorothiazide. *Edward D. Freis, Ilse M. Wilson, and Alvin E. Parrish, Washington, D. C.*

Occurrence of Hypertensive Toxemia in Mother-Daughter Pairs. *J. O'Neal Humphries, Baltimore, Md.*

Re-Examination of the Mechanism of Arterial Hypertension in Patients with Coarctation of the Aorta. *Walter M. Kirkendall, John W. Eckstein, and James W. Culbertson, Iowa City, Ia.*

Work of Digital Vasoconstriction Produced by Infused Norepinephrine in Primary Hypertension. *Milton Mendlowitz and Nosrati N. Naftchi, New York, N. Y.*

INTERMISSION

Evidence for an Extra-Vascular T-1824 Space. *Frank A. Finnerty, Jr., Joachim H. Buchholz, and Robert L. Guildeau, Washington, D. C.*

Severe Arteriosclerosis Produced in the ACTH-Treated Rat. *Bernard C. Wexler and Benjamin F. Miller, Cincinnati, Ohio.*

Renal Rheoplethysmogram of the Dog. *George E. Burch and John H. Phillips, Jr., New Orleans, La.*

Synthesis of the Angiotonin Octapeptide. *Hans J. Schwarz, Merlin F. Bumpus, and Irvine H. Page, Cleveland, Ohio.*

tion, relief of pain occurred in 81 per cent, and no relief or recurrence of pain on the side of operation occurred in 19 per cent. Taking into account the vitiating effect of migration of pain, traumatic neuritis, or the development or increase of cardiac insufficiency, the poor results increased to 29 per cent. Definite or moderate improvement occurred in 71 to 81 per cent of the surgically treated patients, and in 27 per cent of the medically treated control group. Marked to moderate improvement was noted in the work capacity in 66 to 82 per cent of the cases one to four years after operation, in contrast to 27 per cent of the control group. The "general condition" improved in 80 per cent of the operated group, and in 27 per cent of the control group.

Objective evaluation. Postoperatively, the response to the hypoxemic test improved in 55 per cent, deteriorated in 10 per cent, and remained unchanged in the remainder. The response to the exercise test improved in 38 per cent, deteriorated in 3 per cent, and was unchanged in the remainder. Exercise tolerance tests were not performed on the control subjects at comparable times.

Effect of operation on prognosis or survival. There was no difference in the two-year mortality rate between the operated and control groups. The effect of operation on the long-term prognosis has not yet been reported.

To summarize: Cervicothoracic ganglionectomy produced a greater improvement than did medical treatment in regard to anginal pain, work capacity, and general condition. Alleviation of anxiety was frequent and not confined to the relief of pain. This relief may have been partly psychologic, due partly to the operation and to the fact that the patients were under closer medical supervision as a result of the operation.⁵ White also has reported similar results.⁷

Thus, in experienced hands, the treatment of severe angina pectoris accompanying advanced coronary disease can be undertaken with a minimal risk, and with approximately a 70 per cent chance of relief of pain. No claim has been made that longevity is affected.

II. Improvement of the Circulation of the Myocardium

Surgical methods to increase effective coronary blood flow have three objectives:

1. To increase the extrinsic coronary collateral circulation by extracardiac communications. This is produced by anastomosis (a) with various vascular structures (omentum, pectoral muscle, intercostal muscle bundles, left lung, jejunum), or by ligation of the internal mammary arteries; (b) with a systemic artery, such as implantation of the internal mammary artery into the wall of

the left ventricle, or anastomosis of a systemic artery with a coronary artery directly; (c) with the ventricular cavity directly, or indirectly from vascular adhesions produced by abrasion of the pericardium or by pericardial irritants (talcum, bone meal, asbestos).

2. To effect a better distribution of oxygenated blood. This is the aim of stenosis or ligation of the coronary sinus, pericoronary neurectomy, arterialization of the coronary sinus, or chemical or mechanical de-epicardialization.

3. To remove the stenotic lesions of a coronary artery.

Experimental proof of benefit. The design and results of experiments to show the protective value of the above procedures in categories 1 and 2 are remarkably similar.^{17, 18} The extensive physiologic and morphologic studies can be summarized as follows:

1. The mortality rate, following ligation of the left anterior descending artery in the normal dog with a normal coronary circulation, was lowered from 70 to 90 per cent to approximately 10 per cent when the test artery was ligated *after* the experimental "protective" operation. Significant protection was achieved even when thrombosis of an arterial graft from the aorta or left ventricular cavity occurred.¹⁹

2. The amount of myocardial damage was reduced after occlusion of a test artery.

3. Retrograde coronary backflow (flow from the opened end distal to the occlusion) was increased from an average control value of 2 to 3 ml., to 8.5 ml. per minute. This increment of backflow was minute compared to the 60 to 80 ml. backflow occurring after coronary artery occlusion, or coronary artery stenosis in treadmill-exercised animals.²⁰ Coronary backflow was also increased by "sham" operations. The degree of protection seemed unrelated to the type or magnitude of the backflow produced by various operations.

4. Gross and histologic evidence was presented of new vessels of more than 40 micra caliber which were capable of carrying sufficient quantities of blood.

Critique. One must emphasize that no experiments have yet been reported which demonstrate the protective value of the above procedures in dogs with coronary arterial disease, simulated by ligature stenosis or by experimental intimal disease. The most powerful stimulus for collateral formation is local tissue anoxia and it is important to demonstrate that the slight increase apparently produced by surgery is significant. In none of the surgical procedures has the volume of the injected anatomic collateral bed, or the retrograde flow, been of the order of magnitude observed with chronic ligation of the coronary artery (60 to 80 ml. per minute).

In the coronary venous maneuvers, the backflow was 12 ml. per minute, and with other procedures, 8 to 9 ml. per minute.¹⁷ In humans, the existence of large intercoronary anastomoses in all patients with advanced coronary arteriosclerosis²¹ suggests that a maximally developed intercoronary vascular network may have developed. As yet, no scientific proof has been presented which demonstrates the value of the minute intercoronary collaterals produced by the above procedures in animals, with an impaired coronary tree analogous to that found in coronary disease in man.

One should use caution in applying concepts, based on experiments on animals with normal coronary arteries, to humans suffering from occlusive coronary disease. An excellent example is the difference in the effects of aorta-coronary sinus anastomosis in dog and in man. This is feasible and tolerable in the former, but not in the latter.²² Another example is the conjecture that surgery protects the heart from fatal ventricular fibrillation. Since surgical procedures reduce the incidence of death by *ventricular fibrillation* after ligation of a coronary artery of a dog with a normal coronary tree, the assumption is made that the human being with occlusive coronary disease benefits similarly. It has been postulated that a minute improvement of intercoronary collaterals would result in a more uniform oxygenation of the myocardium and would prevent the development of electrical potentials between ischemic and nonischemic areas, capable otherwise of producing ventricular fibrillation.²³ Regardless of the merits of this interesting speculation, the mechanism of death in acute infarction in man differs from that of the dog, although both show similar ischemic electrocardiographic changes. The dog develops ventricular fibrillation. However, in more than 60 per cent of humans dying from acute coronary occlusion, atrioventricular block and ventricular and atrial asystole occur.²⁴

Clinical application. The efforts devoted to the development of experimental surgical procedures to improve coronary circulation have not been matched by a similar expenditure of effort in the design of the clinical application. Although more than 1,000 patients have been subjected to surgery in the past several decades, there have been no reports with comparable controls concurrently treated medically. The criteria for the selection of candidates for surgery have varied, with the same and different surgeons, to include disabled patients with severe angina not relieved by medical therapy, asymptomatic anxious patients with slight or no angina, and those with a diagnosis or predisposition to coronary artery disease.

The results of operation have been evaluated in most studies by:

1. Changes in symptoms of angina and anx-

iety, using the patient as his own control.

2. Ability to work or exercise, again using the patient as his own control. A study should be, but has not yet been made, comparing the results of a surgical and a nonsurgical multidisciplinary approach, i.e., anticoagulants, nitrites, dietary and exercise regimens, in returning otherwise similar patients to gainful occupation.

3. Prolongation of life after operation.

Mortality rate. The mortality rate has varied with the preparation and selection of patients, with the type of surgical procedure, and with the improvement of operating room teamwork. The now-abandoned aorta-coronary sinus anastomosis, and pectoral-cardiac anastomosis operations, had a mortality rate of approximately 25 per cent. The other current procedures have an average mortality of approximately 3 to 6 per cent for patients with no angina at rest, to 45 per cent for patients with angina decubitus.

Complications. Serious complications have been relatively infrequent in the simpler procedures. Mediastinitis, left lower lobe atelectasis or consolidation, pleuritis or incisional pain have occurred in over 50 per cent of the cases but have been of minor importance. In the aorta-coronary sinus anastomosis, cardiac enlargement occurred in one-half of the cases, congestive heart failure in 40 per cent, and acute myocardial infarction in 15 per cent in the operative or immediate postoperative period. Severe obliterative phlebosclerosis of the coronary venous system has been noted several years after operation. Electrocardiographic evidence of pericarditis occurs in practically all cases, and obscures the postoperative diagnosis of acute infarction. Ventricular arrhythmias occur uniformly during pericardial abrasion and myocardial manipulations, and less commonly with topical applications of chemicals. Serious arrhythmias, hypotension and electrocardiographic evidence of ischemia, often reflect the intolerance of the heart to coronary sinus ligation or stenosis. Neither the syndrome similar to that which occurs after mitral commissurotomy nor postoperative compression have been reported.

Criteria of benefit were determined as follows:

Subjective evaluation. The relief of pain and anxiety resembles that which occurs after denervation. Immediately following operation, in some patients there appears to be dramatic and immediate reduction of the amount of pain. This improvement may be mental. Part may be due to concurrent use of narcotics. The best results are almost unbelievably good.²⁵ The psychologic effects of cardiac surgery have been recognized also by others. The patients feel that the most has been done and often acquire a zest for living. This increased confidence often results in the patient's resumption of previous activities and a desire to work.²⁶ Diminution of pain has been reported in approximately 40 to 75 per

cent of the survivors of each of the various procedures.^{18, 26, 27, 28}

In one large series, more or less complete relief of pain was reported in 45 per cent, with an additional 45 per cent claiming a reduction of pain.³ However, the author's recent experience with 20 patients subjected to the same operation has not been so favorable. These patients were evaluated at least three months after operation with a multidisciplinary approach, i.e., vocational, social, psychologic, and medical. Relief of pain was reported in 25 per cent of the cases, psychologic relief in 60 per cent, and improved vocational status in 10 to 25 per cent. The differences of results undoubtedly reflect the importance of sampling, and time and method of evaluation.

Recurrence of cardiac pain has been reported in 10 to 25 per cent of the cases within two years.

The ability and desire to work has been reported to improve in 50 to 90 per cent of the survivors of surgery. A similar number of non-operated cases with sufficient coronary insufficiency to be considered surgical candidates have been returned to gainful work by work classification clinics. Since many noncardiac factors (social, vocational, and emotional) influence the patient's work capacity, it is unfortunate that no series has been evaluated with a multidisciplinary approach before and after operation in order to determine the true (nonpsychologic) influence of surgery on the ability to work.

Objective evaluation. There is no statistical evidence that any coronary operation prolongs life. The use of Lindgren's Swedish series⁵ as a control for American studies a decade later is hardly justified. Thompson²⁸ has claimed that the life span of his "terminal and completely incapacitated" cases has been lengthened, since they lived 9.5 years as compared to 4.5 years for the nonoperated coronary cases studied elsewhere. Recently, however, a better outlook for medically treated cases has been reported, viz., an average survival of 8 to 10 years.

Tolerance to exercise. Subjectively, 40 to 67 per cent of the patients have experienced an increased tolerance to exercise. However, the response to exercise tolerance tests has not improved comparably. In the author's personal experiences with two types of operations, 70 per cent of the postoperative tests showed no change from the preoperative status. In the remainder, the patients with negative tests who became positive after operation were equal in number to those with positive tests who became negative after operation. Dack reports that in 12 out of 19 cases with marked clinical improvement, the exercise tolerance test remained abnormal.²⁶ Similarly there has been no obligate correlation between changes in the ballistocardiogram and the clinical status.³

Protection against myocardial infarction. Failure to protect the heart against further occlusive disease of the coronary arteries was shown by the report that coronary occlusion was the cause of death in 50 per cent of the patients who died six months to five years after operation.³

Direct removal of stenotic lesions of a coronary artery (endarterectomy or anastomotic replacement). The basis of this direct approach rests on the fact that 69 per cent of the occlusions occur in the main branches of the coronary arteries.²⁹ The exact incidence of death due to a single coronary occlusion is not known, but is estimated to be 10 per cent. Usually more than one vessel supplying an infarcted area is stenotic or occluded.

The direct approach necessitates localization of the lesion, which is possible with improved techniques of angiography, and its removal by endarterectomy, by a tunneling technique or by replacement with a vascular graft.^{30, 31} An alternate approach is the direct anastomosis of a systemic vessel to a coronary artery beyond an occlusion. This is feasible in the dog, but has not yet been applied to man.

The clinical experience of the direct approach has been restricted to date and cannot be evaluated. Murray resected the narrowed segment of the anterior descending coronary artery and replaced it with a vascular graft in five human patients.³¹ Acute ischemia of the myocardium was prevented by perfusion of the distal portion of the vessel during the period of surgery. Two successful cases of coronary tunneling were mentioned in a popular nonmedical journal. Two other attempts elsewhere were fatal.

This direct approach may be valuable in the patients with a demonstrable single lesion, preferably in the acute state rather than in chronic cases, where little would be gained by improving the blood supply to a scar.¹⁸

III. Reduction of Metabolic Demands on the Coronary Circulation by Thyroid Ablation

The experimental basis for thyroid ablation in the treatment of coronary insufficiency, and later its clinical application with radioactive iodine, has been summarized elsewhere. Several thousands of severely debilitated euthyroid patients with coronary insufficiency have been treated with radioactive iodine. Predictable relief of angina pectoris and congestive failure occurred in 75 and 60 per cent of the patients respectively.³² Although certain aspects of hypothyroidism are distasteful, it is certainly not anti-physiologic with respect to normal life and activity. A statistical analysis of the effects of radioactive iodine therapy on work capacity and longevity has not been reported.

DISCUSSION

The clinical results of the various surgical approaches and techniques have been remarkably similar.¹⁸ Since their effect upon coronary back-flow appears to be relatively minute, although there is relief of symptoms in some, another mechanism than an increase in blood flow directly resulting from the surgical procedure may be likely. One common factor appears to be effective denervation of the heart or diminished production of or response to epinephrine or sympathetic nervous stimulation, with secondary relief of anginal anxiety. The latter may be a nonspecific psychologic effect of a major therapeutic measure, or a product of the relief of pain. The total effect may result in the patient returning to normal activity. The improvement of intercoronary circulation due to exercise might then be enabled to occur in the previously restricted, fearful, and suffering patient. As mentioned before, the improvement of intercoronary collaterals of the exercised dog with experimental coronary stenosis is significant, and is many times greater than that produced surgically.²⁰ The fact that a similar proportion of patients studied at the Cleveland Work Classification Clinic returned to work *without* surgery and improved twice as frequently as those who deteriorated, would tend to explain the significant benefit that an impressive surgical procedure might have if the patient were encouraged and enabled to resume life activities.

CONCLUSIONS

Many surgical procedures have approximately the same value in protecting the normal dog with a normal coronary circulation against coronary artery ligation. However, there is no experimental proof that surgical procedures protect the heart of an animal with previous coronary artery stenosis or occlusion. No surgical procedure has improved the coronary collaterals more than controlled exercise, or as much as coronary stenosis or occlusion itself.

Relief of cardiac pain and anxiety can be produced equally well in 40 to 90 per cent by all three methods, simple or heroic. The mortality rate has been lowest in the simplest and briefest procedures (de-epicardialization or poudrage). In only one controlled study, that of cardiac denervation, has it been shown that surgically treated patients had significantly more relief of pain, better capacity to work, and objectively better performance on standard exercise or hypoxemic tests than concurrently studied patients who were treated medically.

There is no evidence to date that in patients treated surgically life expectancy is prolonged, that the heart is protected against future coronary

occlusions, or that the capacity to work is better than in patients treated and counseled nonsurgically.

There is sufficient promise in the surgical approach to justify the surgical treatment of coronary artery disease on an *experimental basis only*, with critical pre- and postoperative evaluation by scientific observers over a sufficiently long period (five to ten years). A proper control group of patients treated with various medical plans should be studied concurrently by the same observers.

At best, surgery is palliative. It cannot stop the occlusive process or restore degenerated myocardium. Direct surgical relief of coronary obstruction is now under clinical trial, and may prove to be valuable in patients who have a single local obstruction.

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ANNUAL MEETING OF THE AMERICAN HEART ASSOCIATION

and

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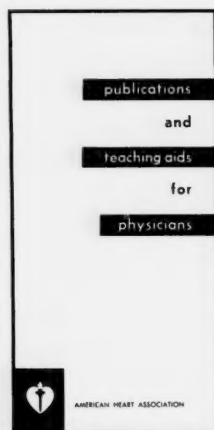
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